Accessing Higher Vibrational States of He_2^+ through Multi-Step Excitation

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The precise measurement of highly excited vibrational states of small molecular systems such as H_2^+, H_2 and He_2^+ is of significant interest as benchmark to *ab-initio* quantum-chemical calculations [1]. In the case of He_2^+, only the first few vibrational levels of the electronic ground state $X^+\ ^2\Sigma_u^+$ were precisely measured [2-3]. In this poster presentation, we propose a method to access the higher vibrational states of He_2^+ $X^+\ ^2\Sigma_u^+$ using a multi-step excitation scheme.

Our approach involves the production of a molecular beam of He_2 in the long-lived metastable a $^3\Sigma_u^+$ state [4] through an electric discharge. We then utilize a high-intensity laser to promote the system to the electronic state c $^3\Sigma_g^+$ in an excited vibrational level with v in the range 3-5. This state predominantly decays radiatively to the a $^3\Sigma_u^+$ state with v' = v because of favorable Frank Condon factors.

A second laser is then employed to induce a transition from the vibrationally excited metastable state a $^3\Sigma_u^+(v')$ to the ion state $X^+\ ^2\Sigma_u^+(v^+ = v')$. This method offers the prospect of studying the structure and dynamics of highly excited vibrational levels of He_2^+ that are typically challenging to access.

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